CONCEPTS

Promoting Patient Safety and Preventing Medical Error in Emergency Departments

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Abstract. An estimated 108,000 people die each year from potentially preventable iatrogenic injury. One in 50 hospitalized patients experiences a preventable adverse event. Up to 3% of these injuries and events take place in emergency departments. With long and detailed training, morbidity and mortality conferences, and an emphasis on practitioner responsibility, medicine has traditionally faced the challenges of medical error and patient safety through an approach focused almost exclusively on individual practitioners. Yet no matter how well trained and how careful health care providers are, individuals will make mistakes because they are human. In general medicine, the study of adverse drug events has led the way to new methods of error detection and error prevention. A combination of chart reviews, incident logs, observation, and peer solicitation has provided a quantitative tool to demonstrate the effectiveness of interventions such as computer order entry and pharmacist order review. In emergency medicine (EM), error detection has focused on subjects of high liability: missed myocardial infarctions, missed appendicitis, and misreading of radiographs. Some system-level efforts in error prevention have focused on teamwork, on strengthening communication between pharmacists and emergency physicians, on automating drug dosing and distribution, and on rationalizing shifts. This article reviews the definitions, detection, and presentation of error in medicine and EM. Based on review of the current literature, recommendations are offered to enhance the likelihood of reduction of error in EM practice. **Key words:** medical errors; prevention; safety; emergency medicine; adverse events. ACADEMIC EMERGENCY MEDICINE 2000; 7:1204–1222

IN THE simplest terms, in the ideal emergency department (ED), the right drug is always given via the right route to the right patient, disposition is always correct, and all likely items on a patient's differential diagnosis are considered for that patient. In the ideal ED, no patient feels forgotten, every nurse and every doctor has adequate support, and every resident and student receives appropriate supervision. All patients rest secure in the knowledge that there are no errors.

Unfortunately, this ideal doesn't exist. Though doctors, nurses, and staff work to the best of their abilities, resulting in generally exemplary performance, mistakes occur in all parts of medicine. To change this requires a reevaluation of assumptions about medical care, about teaching in medicine, and about efforts in pursuit of error-free care.

This paper seeks to investigate how best to determine what clinically significant medical errors occur in EDs and to ascertain what strategies might be taken to reduce or prevent them. Three subject areas must be considered regarding the topic of medical error and patient safety: detection, teaching, and prevention. This is a somewhat artificial division—detection is requisite for prevention, interventions designed to detect might also prevent, and teaching is essential at all levels. The three are separated to simplify the topic; their interaction is understood.

In order to determine where we should head, it is essential to know where we begin and what we already know. This review describes how people have approached these questions in the past, in emergency medicine (EM) and elsewhere in medicine.

MEDICAL ERROR IN THE 1990S

In 1994 Lucian Leape called attention to the troubling and complicated topic of error in medicine with the shocking claim that 180,000 people die of

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iatrogenic injury each year.[1] Still more striking was Leape and colleagues' claim that as many as 60% of these injuries were due to potentially preventable errors. These numbers come from the Harvard Medical Practice Study, a review of more than 30,000 charts from 51 New York hospitals, which revealed adverse events in 3.7% of hospitalizations.[2] Other studies have produced similarly striking results.[3–5]

Since 1994 there have been a number of efforts to study adverse events in medicine and establish strategies to reduce them, including the founding of the National Patient Safety Foundation as a branch of the American Medical Association, the revision of the policy on medical error reporting of the Joint Commission on Accreditation of Healthcare Organizations, and the establishment of a patient safety improvement initiative at the Veterans Administration.[6,7]

Where does EM fit into this? The Harvard Medical Practice Study reported that 3% of adverse events uncovered occurred in EDs.[8] The reviewers found a relatively high rate of adverse events due to negligence, especially associated with misdiagnosis, in EDs. They suggested that this was due to a combination of staffing with part-time physicians who were not necessarily trained in EM, the speed with which these physicians were expected to see patients in a busy ED, and the fact that the sickest patients tend to pass through the ED.

Error in EM differs from error in the rest of medicine for a number of reasons. First is the nature of a typical ED, where time pressures are more intense than on unit floors, and where medical history is less easily accessible than on wards or in operating rooms. There may not be time in an ED, for example, for a drug order to receive central pharmacy review before delivery.[9] Furthermore, inconsistent arrival of patients means that ED staff may be bored and less attentive during slow periods or, more likely, harried during busy periods. In addition, most high-risk patients pass through an ED on the way into the hospital; these patients require more individual procedures and decisions and are, therefore, exposed to more possibilities for error. As if this were not enough, EDs tend to be environments in flux, where patients may be in any of a half-dozen locations—in a room, in a hallway, in radiology, in CT, in a procedure room, or in observation—and where staff rotate every shift. Twenty-four-hour activity makes EDs prone to the errors that arise from contradicting our circadian rhythms. This constant activity also means that there is never a downtime to clean up or to restore order completely. Thus, preventing error and ensuring patient safety in an ED may require different processes from those that work elsewhere in the hospital.

A Few Notes on the Science of Error

The study of error has its origins as early as the 19th century when Freud investigated the roots of slips in speech. Further work in psychology continued through the 20th century, but the application of error theory to industrial practice had to wait until 1979 and Three Mile Island.[10] At that time, concerns about nuclear safety and the safety of commercial aviation led to studies that suggested a system-level approach could best detect and prevent errors. This meant that rather than looking at individuals and deeming every incident the result of a single human's failing, it was necessary to dig more deeply into the history of the incident in order to unearth the many factors that may have led to conditions setting the stage for the incident.[11] One author suggests a Swiss cheese model to describe the occurrence of error; many layers in a system work to prevent error and maintain high quality, but when the holes that inevitably appear in each layer happen to line up, an incident results.[10]

Looking at the systems behind error helped commercial aviation avoid even a single death in 1998 and, relevant to medicine, allowed anesthesia to reduce a death rate of one in 20,000 two decades ago to one in 200,000 today.[1,12,13] So strong is system-level thinking in industries other than health care that Paul O'Neill, a chief executive officer known for marked improvements in workplace safety in the notably dangerous industry of aluminum refining, has stated that "you can't make the safety better without having a profound understanding of your process, and working with the idea of continuous improvement."[14]

Some of these ideas from industry regarding error have long existed in medicine, particularly the idea of continuous individual improvement. Other ideas are relatively new: the need for system-wide thinking, and that error may begin anywhere within a health care organization. Medicine can learn much from industrial approaches, and EM can, in turn, learn a great deal from approaches elsewhere in medicine.

While examining different approaches to error and its prevention, Norman's four points about object design should be kept in mind. He begins from the perspective that humans always err. It is design, therefore, that must take up the slack. His four points have been slightly modified here, to apply to process and to medical care.[15,16]: 1) Understand the causes of error, and design to minimize those causes. 2) Make it possible to undo actions or make it harder to do what cannot be undone. 3) Make it easier to discover and to correct the errors that do occur. 4) Change the attitude toward er-

TABLE 1. Methods Used to Find and Quantify Medical Error

Incident report
Chart review, typically with a three-physician panel
Extensive caretaker observation by trained observers
Daily peer (nurse or housestaff) solicitation regarding adverse events or errors
Incident logs placed in unit medical rooms
E-mail solicitation for information regarding adverse events or errors
Daily reminders and solicitation at morning report
Automated computer screening for indicators of adverse events or errors
Collection of potential events or "near misses"

rors. The admission and study of mistakes are what permit improvement.

DEFINITIONS, DETECTION, AND REPORTING OF MEDICAL ERROR

Definitions. A number of methods exist to quantify errors occurring in any given medical system. The Harvard Medical Practice Study used a two-physician screening panel to determine whether charts contained evidence of adverse events and whether those events "could have been caused by a reasonably avoided error, defined as a mistake in performance or thought."[2,8] Because it relies on retrospective assertion, hindsight bias—the tendency to simplify situations examined after knowing the outcomes—plagues this vague definition of error. Vague definitions have advantages, though. They assume that errors occur throughout the health care system and that health care workers understand intuitively when an error has occurred.

Vague definitions also make specific, quantitative research difficult to conduct. Unfortunately, discussions of terminology tend to bog down researchers, and actual work becomes hard to carry out as progress sticks on the need for an exact definition.

Appendix A reproduces, with some modification, a working definition of medical error developed for an executive conference at the Kennedy School. It is specifically designed to drive discussion toward system-level analysis, to view adverse events as the possible results of many factors, and to move discussion beyond the potential swamp of strict definition.

Methods of Detection and Reporting (Table 1). Multiple methods of error detection have produced varying degrees of success. The system of incident reporting, the most widespread method, in one comparative study revealed so few adverse drug events (approximately 6% of those found via other methods) as to lead the authors to emphasize its severe limitations as a reporting tool.[17] The authors suggest that by making it easier to report, changing institutional culture to increase comfort in reporting, and providing feedback to demonstrate that reporting leads to changes, hospitals can improve incident reporting rates. While not complete, incident reporting can yield a great deal of information. Working only from nurses' incident reports, Groves et al. discovered unintentional incidents, including falls and medication errors, for 2.2% of admitted patients.[18]

Dubois and Brook developed a method of chart review using three-physician panels to determine preventable deaths in hospitalized patients.[19] Localio et al. later raised doubts about the utility of panels.[20] In reviews of 7,533 patient records, with two physicians independently reviewing each record, one physician determined that an adverse event was more likely than not, while the second physician deemed the case free of adverse events, in 12.9% of cases. Two physicians agreed that an adverse event had occurred in only 10% of cases. The two physicians, in other words, disagreed more often than they agreed.

Introducing a different approach, Andrews et al. hired four observers to spend nine months attending regularly scheduled patient care meetings including work rounds, attending rounds, conferences, and shift changes.[21] Any time an adverse event was discussed, the observers noted the event, its apparent cause, its effects, and whether anyone was blamed. Their goal was not necessarily to uncover preventable error, but to develop a catalog of adverse events, their causes, and their outcomes.

Cullen et al. used three methods to collect evidence of adverse events: self-reporting in incident logs; a peer—in this case, a nurse investigator—who once or twice daily visited unit nursing stations to solicit information regarding adverse events; and chart review.[17] Review of medication sheets has also been noted as a productive method of uncovering errors.[22]

O'Neil et al. compared chart review with confidential housestaff self-reporting through electronic mail or written report deposited in a collection box.[4] The two methods turned up similar numbers of events, though the events reported by housestaff proved more amenable to preventive efforts. Self-report also turned out to be substantially less expensive than chart review. A separate study found that daily reminders at morning report, combined with reporting via a patient log traditionally filled out at morning report, doubled the number of events reported in the hospital overall and increased eightfold the number of housestaff-reported events.[23]

The use of computers for both order entry and patient record storage raises the possibility of computerized review as a first step to determine the presence of error. Using three different identification algorithms, Bates et al. judged that more than 50%, and up to 89%, of adverse events were potentially identifiable electronically.[24] As much as 23% of the adverse events judged identifiable were also deemed preventable.

Putting screening systems in place is more difficult, however, as softer criteria pick up more false positives along with adverse events. After examining 15 screening criteria, Bates et al. concluded that no small subset could reliably detect a high percentage of adverse events, much less errors.[25] They pointed out that screening methods are at an early stage of development and will become more sophisticated as more data become available online. LDS Hospital in Salt Lake City had better results with a more specific system screening exclusively for adverse drug events.[26] Criteria included dosage decreases, ordering of antidotes, and laboratory tests for drug levels.

In an atmosphere where actual error is difficult to discuss or raises questions of liability, more success might be had asking about potential errors or "near misses." For example, pharmacy review of entered orders can detect potential medication errors—errors that are caught and corrected—collecting them for categorization and analysis.[27,28] Indeed, one can modify all methods of error collection to collect near misses. Rather than asking housestaff to report patients who were injured as a result of care, for example, one might ask about patients who might have been injured but for some fortuitous realization. In this regard, it is notable that the aviation reporting system collects more information on incidents where safety is threatened than on incidents where physical harm occurs.[29]

General Approaches to Error in Medicine

Is there more error in medicine than in any other field? The question provokes argument but has generated little research. Numerous reasons do exist (Table 2), however, suggesting why the practice of medicine might entail a higher incidence of errors.[1,30] First among these is the complexity of medical practice. Doctors, nurses, pharmacists, and other health care workers likely err no more than individuals outside of hospitals, but each patient who encounters the medical system receives attention from multiple people performing multiple tasks. One analysis in a medical intensive care unit (ICU) discovered that each patient was the subject of 178 distinct activities—including receiving medications, visits from physicians, and general nursing care—during each 24 hours.[30] Even if 99% of tasks were performed perfectly, this still meant that each patient was the recipient of more than one error, on average, every day.

TABLE 2. Reasons Why Medicine Might Be Prone to Error

High complexity
Lack of standardization
Failure to design with error in mind
A medical culture that resists admitting to error and so cannot work to prevent error

TABLE 3. Traditional Methods for Error Detection, Teaching, and Prevention in Medicine

Autopsy
Incident reports followed by case investigation
Long and detailed training
Continuing medical education throughout career
Morbidity and mortality conferences
Strong sense of personal responsibility
Legal system designed to root out and punish error

Leape has suggested that a central reason why the medical community has not tackled this subject more strongly lies in a medical culture that imbues caretakers with a belief that they must be infallible and that associates error with negligence. This culture leaves little room for the examination of error and less room for the expiation of the individual who, as all will, makes one.[1,31] A series of focus groups conducted at three different health care organizations recently confirmed Leape's perspective. Though staff reported a trend in health care to move away from blaming employees, they wondered how an organization could both hold individuals accountable and be nonpunitive.[32]

Traditional Methods for Error Detection, Teaching, and Prevention. Medicine has a number of traditional methods for the detection and prevention of error, as well as for teaching about error, that are worth considering for several reasons (Table 3). First, these methods provide a sense of the traditional importance of this topic to medicine. Second, they allow us to gain a sense of where medicine has succeeded and where it has failed in the prevention of error. Third, they provide a foundation on which to establish new practices.

Detection. Autopsy is a traditional and powerful method of evaluating diagnostic accuracy. Several studies have taken the next step to look at error as a reason for misdiagnosis. A 1957 study of 1,106 autopsies revealed a 6% misdiagnosis rate at one Veterans Administration hospital, half of which were attributed to potentially avoidable errors of omission.[33] A more recent Veterans Administration

study revealed a 13% rate of major clinical errors, defined as inappropriate therapy possibly leading to the patient's death, though no attempt was made to distinguish treatment errors that might reasonably have been avoided from those that could not.[34] Despite calls for a return to more frequent use, the autopsy rate has declined substantially over the last few decades.[35]

Autopsy is not unknown in EM. In 1990, from a series of 244 autopsies, Burke et al. reported a 4% rate of major unexpected findings and a 5.8% rate of minor unexpected findings.[36] A 1994 study in a pediatric ED uncovered a 15% rate of major diagnostic disagreement between clinical and autopsy diagnoses, none of which were thought likely to have led to cure or prolonged survival if discovered in time.[37] Neither study distinguished potentially preventable diagnostic error from unavoidable misdiagnosis.

In addition to autopsy, incident reports, which require self-admission of error, permit individual case review. Some argue that few incidents go unreported because the nursing profession, especially, emphasizes the important role of reporting and because the sanctions for concealing an incident outweigh those for admission.[18] As the following discussion reveals, however, empirical evidence strongly suggests that written incident reports may not provide a complete accounting.[17]

Teaching. Long and detailed training is a fundamental method of error prevention for physicians and, with less emphasis on length but more on explicitly delineated duties, for nurses. So entrenched is this notion that Rosen et al. write "the true point to a residency is to avoid repeating preventable errors."[38] Professional continuing education throughout one's career augments this long training. Both of these methods focus exclusively on the individual as the source of error and therefore as the solution.

Morbidity and mortality conferences (M & Ms) tend to focus on the individual as well, often with one person assuming responsibility by presenting the case before a committee of demanding critics. Morbidity and mortality conferences, though, can be broadened to examine many components of clinical care, including explicit discussion of error prevention, communication among actors, and systems failures that contributed to an event.[39,40] Such broadening helps M & Ms overcome limitations such as a tendency toward fault-finding and an emphasis on outliers.[41]

Prevention. The strong sense of personal responsibility imbued during medical training might appear on both a list of practices that prevent error and a list of practices that make medicine prone to error. The excessive care taken when one's self-assurance and reputation are constantly at stake probably lowers the error rate for individual tasks in medicine. Unfortunately, vigilance has its limits. This sense of personal responsibility also prohibits easy admission of error and, consequently, complicates the collection and analysis of error.

Whether the tort system works beneficially to prevent error by enforcing a high degree of individual responsibility or whether it promotes an atmosphere of fear in which free discussion becomes impossible is a matter of debate. It has, nonetheless, generated a method of targeted examination in the form of closed case analysis.[42,43]

It is interesting to consider traditional mechanisms of error detection and prevention in light of the lessons that one author says we can learn by examining high reliability organizations. Grabowski and Roberts state that the need for good communication cannot be overemphasized, that organizations require flexible structures to adapt to environmental changes, that a strong organizational culture emphasizing norms of safety is essential, and that one must pay attention to the interfaces in the system.[44] In concentrating on individual propensity for error, most of medicine's traditional methods fall short. They may yield a safer system if pushed further and broadened; another approach, however, is to redesign the processes of care to include system-level methods of both error detection and prevention.

Adverse Drug Events: Examples Illustrating System-level Approaches. The Harvard Medical Practice Study revealed that the largest number of adverse events in medical care occur around the ordering and delivery of medication.[2] Adverse drug events, though, while relatively common and easy to identify, do not imply error. They can be normal complications of care.

A further study concluded that adverse drug events nearly double the length of stay and the risk of death in hospitalized patients.[45] One-half of the events were preventable. Bates et al., working in a teaching hospital, revealed a rate of 6.5 adverse drug events per 100 admissions, of which 28% were preventable.[46]

Evans et al. examined computer-assisted management of antibiotic choices in ICU patients.[47] A combination of computer order entry and assisted decision making reduced overall adverse events secondary to drugs ordered, including instances in which a patient received a drug known to have precipitated an allergic reaction in the past. The combination of online medical records, up-to-date pharmaceutical recommendations, and use of the most immediately available patient information makes this system a model for what is possible with computer-based drug ordering.

Good Samaritan Regional Medical Center in Phoenix reported that a computer alert system, using 37 rules to trigger real-time computer order entry responses, alerted physicians to the potential for adverse drug event-related injury in 64 of every 1,000 patient admissions.[48] The authors concluded that such decision support systems provide critical information at appropriate times, benefiting patient care while also being cost-effective.

A multicenter study in the reduction of adverse drug events developed a series of approaches to improve the ordering, dispensing, and administration of medications.[49] The approaches included efforts to reduce reliance on memory by using preprinted orders and computer order entry; simplification by limiting the number of drugs on formulary and moving intravenous (IV) admixture to the pharmacy; and standardization by restricting the number of dosing options for specific drugs. Other methods entailed using protocols and checklists for hazardous drugs, having pharmacists round with doctors and nurses, and eliminating look-alike drugs by repackaging where necessary to call attention to easily confused medications.

Methods Of Error Evaluation Specific to EM

Rosen and colleagues noted in 1983 that, since its inception as a specialty, EM has reflected on medical error and taken innovative approaches to its prevention. First among these was calling for 24-hour on-site attending coverage during resident training specifically "to minimize or avert technical error."[38,50] This intervention has been credited with averting 17 life- or limb-threatening errors in a sample of 1,000 patients seen by non-EM residents.[51]

What follows is a review of approaches to medical error and patient safety used and studied in EM. Presented are methods of detection, both narrowly targeted and more general; methods of teaching; and system-level approaches to prevention of error in EDs.

Detection and Reporting.

Targeted Approaches. Several areas in EM, typically described by diagnoses, have garnered attention for highly focused research. Among these are missed myocardial infarctions (MIs), appendicitis, and trauma, areas that suggest measures for tracking error.

Missed MIs. McCarthy et al. found from a sample of 1,050 patients with acute MI that 20, or 1.9%, were not admitted to the hospital at initial presentation in the ED.[52] Examination of ED records revealed that half of the episodes of missed MI were preventable based on what was known in the ED at the time.

Targeted, retrospective studies, however, have several limitations, chief of which is the hindsight bias to which any retrospective approach is prone. It is exceptionally difficult to reproduce the conditions that lead to a clinical decision. Knowledge of the outcome biases one's judgment of the processes producing that outcome, reducing the number of possibilities considered from the original information and making what was difficult to determine a priori seem obvious ex post facto.[53]

Appendicitis. Rothrock et al. illustrated another approach in their study of misdiagnosed appendicitis in children under the age of 13 years.[54] They retrospectively examined 181 cases of surgically treated appendicitis, 50 of which were misdiagnosed at initial presentation, seeking to determine what complicated early recognition.

This approach can be difficult to generalize because initial examinations may have taken place outside hospitals or clinics. Nonetheless, the rate at which a relatively common, probable diagnosis is missed on initial presentation is an adverse event measure. The frequency of misdiagnosis due to avoidable error is a refinement that requires chart review and may be subject to disagreement among reviewers.

Trauma. Treatment of trauma is central to EM, as is examination of the accuracy of that treatment.[55] One method used to assess diagnostic accuracy consists of comparing injury severity scores calculated for patients at the time of ED presentation with a severity score calculated from final diagnoses at discharge or death. A discrepancy between scores is taken as evidence of diagnostic error. Tulloh used this method to demonstrate a 29% discrepancy rate in a series of 203 head-injured patients.[56] Inaccurate reading of radiographs accounted for most of the misdiagnoses. Greater discrepancies were found in patients who were comatose on presentation, defined by a Glascow Coma Scale score (GCS) of less than 8. While the comparison of severity scores gives little indication of the clinical import of the discrepancy, it provides a mechanism for detecting both over- and underdiagnosis. Additionally, this study suggests the use of a patient's initial GCS as a predictor of misdiagnosis.

System-level Approaches.

Radiology Reviews. Because of the importance of missed fractures to ED malpractice claims, and the centrality of imaging to emergency diagnoses, radiographic interpretation is a clear topic for study in EM.[57] It is also a Joint Commission requirement.

One review of 12,099 radiographs found that at-

tending emergency physicians (EPs) and radiologists had discordant readings only 1% of the time, and then only one-half of these misses necessitated clinical follow-up.[58] Gratton et al. found a 2.8% rate of clinically significant errors in an EM residency program.[59] The investigators pointed out difficulty in using such ratings as quality measures because the results varied depending on definition and whether one included borderline cases in rate calculations.

Pediatric ED analysis of 1,471 radiographs revealed a clinically significant misread rate of 1.4%, with attending physicians having a slightly lower rate than housestaff and with both having the highest error rate in reading extremity films.[60]

Cranial computed tomography (CT) scans in a study of 555 films had a much higher discordance rate than plain films when read by both EPs and radiologists. Clinically significant misinterpretations were found in 24.1% of cases, though only a much smaller 0.6% of patients were managed inappropriately following these misinterpretations, and none had adverse outcomes.[61]

Literature review reveals a few prospective studies of interventions designed to reduce reading error. One might imagine several interventions, ranging from 24-hour radiologist review, to standardized checklists for high-risk misreadings, to regular conferences designed to prevent those errors that have been noted to occur. Preston et al. reported that a continuous quality improvement intervention designed to strengthen physician communication and increase radiologist availability for consultation succeeded in a 40% reduction of patient callbacks.[62] Mann and Danz examined the effect of assigning radiology residents to month-long dedicated nighttime swing rotations.[63] Residents freed from daytime duties missed fewer radiological diagnoses than residents covering the ED on-call after a full day of work, a result the investigators believed was due to the residents' getting more sleep.

Computer-based Medical Records. Though medical quality assessment has used administrative data since the 1970s, their use has fallen short of expectations.[64] In an effort to foster the collection of clinical data in EM, the Centers for Disease Control and Prevention have sponsored an effort to develop uniform standards for computer ED records.[65] Which elements of this data set will be most applicable to the study of patient safety remains to be determined.

In the meantime, an ED with fully computerized records has an opportunity to develop error detection methods using both administrative and patient care data. A number of studies suggest measures with which to begin, primary among these being unexpected returns. Keith et al. found that almost 40% of patients who made unscheduled return visits to a Detroit ED within 72 hours of their initial visits did so for avoidable reasons: a deficiency in medical management, in prescribed follow-up, in patient education, or in patient compliance.[66] Eighty-five percent of these visits occurred in the first 48 hours, implying that a two-day time frame may be sufficient for data collection. The authors suggest developing a more efficient method of detection by conducting a single month-long chart review in order to determine high-risk categories; these high-risk categories can then be used to refine continuing searches and analyses. Pierce et al., using a two-day criterion, found a 3% return rate from 17,000 visits.[67] Ten percent of returns were deemed due to error in diagnosis, treatment, or disposition. Patients returning for one of these three reasons were more likely than other returnees to require hospitalization.

Another potential indicator lies in comparison of ED admission diagnoses with hospital discharge diagnoses. With fully computerized ED charting and online hospital discharge summaries, such comparisons become feasible and their follow-up record reviews simpler. Kothari et al. used this method to examine the accuracy of EPs in diagnosing stroke.[68] Warner and Peabody used it to determine the accuracy of emergency psychiatric diagnosis.[69]

Fully computerized medical records also raise the possibility of easier hospital-to-hospital transfer of information. A Boston group hopes to establish a system of shared medical records through the World Wide Web with the goal of providing rapid access to information during an emergency.[70] The benefits of a readily available medical history to the prevention of error are obvious. The resistance to such a system lies in the risk to confidentiality.

Finally, increasing use of computers in EM suggests a natural transition to a smart medical record that requests appropriate information and prompts appropriate action.[71] A group at UCLA generated substantial increases in documentation and compliance with recommendations for testing, with no increase in per-patient cost, through the use of a computer-based guideline for the treatment of health care workers after occupational exposure to body fluids.[72,73] Implemented in a busy ED, this study illustrated the feasibility of computer-based interactive guidelines.

Teaching about Error. Drawing from the results of a questionnaire completed by 114 internal medicine houseofficers, Wu et al. suggested that encouraging discussion of mistakes with attending physicians along with encouraging acceptance of

responsibility with a view toward constructive change would better equip residents to learn from mistakes made during training.[74] They believed that medical educators have a role in dispensing specific advice about preventing a second occurrence of the mistake, providing emotional support, and helping residents interpret the feelings of distress that are part of learning from error.[75] These approaches would differ greatly from what Mizrahi observed during a sociological study of graduate medical education: "Little in their 3 year graduate program allowed them to work through the attendant vulnerability and ambiguity accompanying the managing of mistakes."[76]

To the best of my knowledge, no equivalent studies have been undertaken in EM. Two innovative approaches to error and teaching used in EM are video recording and simulation.

Video Recording. After using videotape to review 73 trauma resuscitations, Santora et al. concluded that this was an effective method both for teaching residents and for detection of system problems.[77] Videotape provided an opportunity for reflection and analysis in a controlled environment while also providing a relatively complete record that allowed the review team to detect subtle system deficiencies—inconvenient locations of supplies and inefficient intravenous equipment access, for example—that might otherwise be missed. Counting deviations from Advanced Trauma Life Support protocols provided a quantitative measure of performance. Hoyt et al. reported, after three and a half years of incorporating videotape into trauma rounds, that the method allowed feedback not only on individual adherence to assigned responsibilities and resuscitation priorities, both of which improved, but also on the relationship among members of the trauma team.[78] Disadvantages noted in the use of videotape include that it can be tedious and time-consuming and miss bits of sound and pieces of the field.[79] As for the question of medicolegal liability, Hoyt et al. received the advice that so long as patient anonymity was maintained, use of video was not a problem.[78]

Simulation. Simulation can refer to anything from interactive question-and-answer re-creation of a patient encounter to technologically advanced models of operating rooms where lifelike, computer-controlled manikins assume the roles of patients.[80] Recent interest borrows from aviation, using simulation in teaching not only physical skills but also teamwork and communication skills. Anesthesia has led the way, using screen-based simulation to look at the effectiveness of Advanced Cardiac Life Support training in individuals and using full-sized operating suites to examine and train the interpersonal aspects—team composition, attitudes, and intergroup norms, for example—involved in team-based medical care.[81–83] The field has generated sufficient interest to establish several high-fidelity anesthesia simulators and at least one company that markets simulators for procedural training in IV catheterization and endoscopy.[84,85]

Basic life support courses for both laypersons and professionals have used manikins to teach procedural skills. Eberle et al. called the value of even this established method into question when they reported that 45% of emergency medical technicians and paramedics failed to recognize a carotid pulse in anesthetized patients.[86] They questioned whether overreliance on unrealistic manikins might work against the acquisition of clinical skills and increase error by training with inappropriate feedback. Other procedural uses of manikin simulators in EM include testing houseofficer and attending physician skill at auscultating cardiac murmurs and teaching the skills of cricothyroidotomy and thoracotomy.[87,88] The development of virtual-reality simulators, which would immerse the trainee in a three-dimensional computer-generated environment, suggest where such efforts might head, though the development of such programs is expensive and the true educational benefits have yet to be established.[88]

Preventing Error: System-level Approaches.

Teamwork. In aviation, much work in simulation goes hand in hand with the study of teamwork. This was the result of research into commercial airline crashes revealing that human error accounted for a majority of incidents and that interpersonal failure—failures in leadership, communication, decision making, or group awareness of the situation—explained the majority of human error.[84] Helmreich and Schaefer found similar causes for error in the operating room.[83]

Extensive work has been conducted analyzing the role of patient care teams in the care of trauma and stroke patients.[89–91] Somewhat less work has been done examining the role of teamwork and error in EM as a whole. Recently, Jay et al. reported that a retrospective review of 54 malpractice cases revealed an average of nine teamwork failures per case.[92]

Human factors experts note that medicine has tended to focus on technical proficiency more than the dynamics of human interaction. They call for more attention to the latter:

> In safety sensitive cultures such as operative or emergency medicine, information flow is critical. . . . Ideas and concepts must be actively sought, discussed and evaluated without regard for the status of the person or group having such information. . . . In view of the

> fact that communication is at the heart of every team's activity, it is surprising how little attention this process factor has gained in the medical literature.[93]

They call for an examination of the "cultural shell" in which teams operate, with more detailed attention paid to communication among team members.

A group working with Dynamics Research Corporation in Andover, Massachusetts, is working to translate lessons from U.S. Army aviation to emergency care. Using skill- and behavior-oriented methods designed to promote effective interaction, methods such as verbal order check-backs and two-challenge rules, they hope to demonstrate efficacy through measures of team behavior, attitudes and opinions, and ED performance.[94] Reduction of medical error is one of the principal aims of these efforts.

Pharmacy and Prescribing in the ED. Wingert et al. found that of 2,213 prescriptions written by housestaff in a California pediatric ED, 33% contained dosing errors and 95% were incomplete according to the broader specifications that all prescriptions contain medication quantity, dosage, interval between doses or hours to be given, and any appropriate special instructions.[95] Pharmacists corrected dosing errors less than 10% of the time; most errors made their ways to patients' medicine cabinets.

Johnson et al. telephoned the caregivers, typically parents, of 192 discharged pediatric inpatients and asked them to read the labels from received prescription medications.[96] Comparing these conversations with copies of the original prescriptions and discharge instructions, they detected discrepancies in 12%. Half of the discrepancies arose from errors in the original prescriptions. Transcription errors caused discharge instruction sheets to differ from prescriptions in another 3% of cases. Patients also received medications packaged differently than discharge instructions assumed, thereby increasing the risk of error with new confusion. These results suggest that proxy measures of error might be obtained by asking patients, during routine follow-up after an ED visit, to read the labels of received prescriptions over the telephone and comparing them with ED records.

Herr et al. prospectively studied potential adverse drug interactions through the use of a drug interaction database into which were entered a patient's current medications and any new medications delivered in the ED.[97] They found that of 199 visits, 26% of ED patients were exposed to potential adverse drug interactions and 3% had clinically significant responses as determined by a three-member physician review panel. Using a retrospective design, Beers et al. revealed a 10% rate of exposure to potential adverse drug interactions among ED patients who received at least one prescription.[98] Furthermore, the authors found little in patient charts to indicate that the prescribing physicians recognized the potential for adverse interactions; therefore, any interaction would have been the result of error. The high percentages of potential adverse events highlight the benefit of an interactive charting system able to call attention to known drug interactions.

A number of hospitals have experimented with 24-hour on-call pharmacy consult services or placed a pharmacist in an ED for part or all of the day.[9,99–101] Berry et al. reported that a clinical pharmacist consultation service yielded consultation in 3% of all ED cases.[102] More frequent use of the service occurred during July, suggesting a benefit for new housestaff. They did not, however, measure error prevented through pharmacy intervention. Powell et al. described a 24-hour satellite pharmacy in a 75-bed ED.[103] From the satellite, pharmacists mixed and distributed drugs, tracked inventory, took part in work rounds, instructed students and residents, and concurrently reviewed all medication orders. They described substantial benefits to patient care from pharmacists' clinical, distributive, and educational services. Whalen described a combined outpatient and ED services pharmacy that proved cost-effective while increasing physician confidence that patients were filling their prescriptions.[100]

Though not conducted in an ED, a study by Bates et al. sheds light on the relative contributions of computer order entry and increased availability of pharmacists at points of medication ordering.[104] Computerized physician order entry was implemented in eight hospital units, including medical, surgical, and ICU wards, with a team intervention also implemented in half the units. The team intervention included increasing communication between nursing staff and pharmacy via written logs and changing pharmacists' schedules to permit more of a physical presence, including daily rounds with the ICU study team. A combination of incident reporting, twice daily solicitation of information from nurses, pharmacists, and clerical personnel, and daily review of all patient charts determined rates of preventable medication errors and potential adverse drug events. Overall, the physician order entry system prevented 55% of serious medication errors, a combination of an 84% drop in non-intercepted potential adverse drug events and a 17% drop in preventable adverse drug events. In other words, the system reduced error, though with a larger decrease in potential adverse drug events than in errors that actually led to events. There was no significant difference in error reduction rates between physician order entry plus

team intervention and physician order entry without increased pharmacist availability. The authors noted that the success of physician order entry may have overshadowed any effect of the team intervention.

Automated Drug Dosing and Distribution. Systems are being developed to automate drug dosing and delivery. One such system is the Pyxis automated drug delivery system (Pyxis Corporation, San Diego, CA).[105,106] Its advertised advantages include controlled access to medications and improved reporting of medication use with automated charting. The use of bar code technology for dispenser refilling suggests the ability to prevent error through better inventory control. It also heralds the use of bar code verification at the bedside.

In discussing the experience of installing an automated system, Magnus raised the important risk of creating error while establishing systems designed to streamline processes.[107] He suggested regular interdepartmental meetings to discuss who will have access to the machine, what medications will be stocked, and when restocking should take place. He warned that problems will occur, specifically with passwords that may be forgotten, with mechanisms that can jam, and with routines that have yet to be established. The overall lesson of his laundry list of warnings is that system-wide interventions have system-wide effects. Though these effects are expected, interdepartmental planning and cooperation can help smooth the way to successful implementation and error reduction.

The Organization of Shifts. The nature of EM as shiftwork is one of the features that sets it apart from much of the medical world. Examination of shiftwork in industry has revealed that it creates risks to shiftworkers' emotional states and physical well-being.[108] Increased incidences of single-vehicle car and truck collisions, gas company meter-reading errors, and even engineering disasters have been noted to occur at predictable times in the early morning and early afternoon.[109] This research has informed recommendations in EM for eight- or ten-hour shifts, isolated single night shifts or designated long periods of night shifts, clockwise rotation of shifts, and physiologic eating patterns.[110,111]

Comparatively little work has been done to look at the process of shift change beyond determining that EPs, when asked, cited erratic schedules and shift changes as stressors in ED work.[112] Macias et al. determined that hospital employees had a higher rate of exposure to biological fluids, such as needlesticks and splashes, during the first hour of any shift and during the last two hours of a 12-hour shift.[113] While the results presented are generalized, with only a fourth of incidents arising in an ED, this study suggests the challenges inherent in shiftwork and the lapses that can occur around change of shift. In addition, it suggests a proxy measure for ED safety in tracking the rate of staff exposure to biological hazards.

RECOMMENDATIONS

Beyond simply preventing error, recommendations must seek to foster the development of a culture of safety in EDs. Hopefully, medicine will eventually view error with the same wisdom that aviation views error: knowing that it exists while seeking constantly—through the most effective means known—to prevent any ill effects. For this to occur, patient safety must become part of the everyday thought of ED physicians, nurses, and staff.

Recommendations to reduce error within an ED must consider[114]:

- The mission of the ED, within its local community.
- The technical and organizational constraints of the ED.
- The politics that surround error in medicine and patient safety.

Though a movement in patient safety is gaining momentum, there are significant barriers to progress. Among these barriers are 1) the underlying threat of malpractice litigation after having revealed one's own mistakes, 2) the more subtle threat of professional disrepute as one appears to err more frequently than quieter colleagues, and 3) the traditional medical focus on individual responsibility to the exclusion of system-level thought. To approach the vision of error-free care requires action in the overlapping areas of detection, teaching, prevention, and research.

Detection and Reporting.

Develop, Establish, and Follow a Few Specific Indicators of Patient Safety and Medical Error. Any quantitative measure of error, in order to suffice for general quality assurance as well as support prospective research into methods of error prevention, should be reliable, allow consistent comparison over time, be specific to the ED, and be easily understood as measuring error.

Tables 4 and 5 present a selection of measures of error. Ideally, a single, obvious measure would define patient safety in the ED. Industry has accomplished this with measures such as number of serious injuries per 100,000 worker hours.[115]

Chart-based Methods. Physician or nurse panel review, automated review, and the use of proxy measures are all based on analysis of patient

TABLE 4. Measures of Patient Safety and Medical Error Based on Chart Review

Unexpected patient returns to the emergency department (ED) in under 48 hours
Discharge diagnoses differing from ED disposition diagnoses
Percentage of patients admitted to the floor who are subsequently transferred to an intensive care unit
Unexpected events based on automated review of a sample of charts using multiple, targeted criteria
Episodes of adverse events or preventable error noted on physician panel chart review

TABLE 5. Measures of Patient Safety and Medical Error Based on Other Methods

Tally of incident reports
Tally of self-reports via e-mail or error logs
Tally of events reported with peer solicitation
Survey of primary care physicians as to whether patients have experienced any unexpected events following an emergency department (ED) visit
Staff perception scale of safety in the ED
Percentage of radiographs read requiring patient recalls
Percentage of electrocardiograms read requiring patient recalls
Percentage of discharged patients reporting adverse event, injury, or error on follow-up call
Percentage of autopsy diagnoses differing from ED diagnoses for patients dying within 48 hours of ED visit

charts. None of these methods permits absolute reliability, reproducibility, and validity. Neither, in the young field of patient safety, has any been widely demonstrated or applied in EM. All three methods, however, are a step forward in the development of more reliable indicators. They may also be used in combination with one another.

Chart review by a physician or nurse panel allows one to quantify episodes of adverse events and preventable error over time. This approach can be problematic. It is expensive except for small samples, too few data may be produced to demonstrate a significant difference, and review teams will produce inconsistent assessments unless the same panel carries out the analysis each time.

Automated chart review can make use of computerized medical records. Target criteria for the Harvard Medical Practice Study that might be automated included death during hospitalization or transfer to an ICU.[116] A targeted, automated chart review generates reproducible data. The difficulty lies in determining measures with sufficient sensitivity and specificity to indicate error rather than normal care.

A two-stage method uses automated review first to find cases that likely contain adverse events. Physician review follows in order to determine whether the high-probability cases actually contain notable events or error.

Bates et al. tested a different two-stage refinement for hospital inpatients. They ran electronic screens to find surgical patients who were readmitted to the hospital or returned to the operating room, both suggestive of adverse events. Then, at the patient's discharge, they asked residents whether these returns were unexpected.[117] Whether an equivalent method might work in an ED, where one physician may see more than 25 patients in a shift, has not been investigated.

Finally, single proxy measures, such as percentage of ED return visits less than 48 hours, can indicate patient safety. One disadvantage of individual proxy measures is that they may retain only a distant connection with error, making them difficult to analyze and explain. Patient satisfaction, for example, a notable goal in its own right, may less accurately report safety than good impressions made through well-appointed rooms or kind words.

Self-report. Incident reports and peer solicitation of events all require ED staff self-reporting. The number of events reported depends on perceptions of punishment or reward for reporting and on personal evaluations of any positive outcome. To maximize self-reporting requires acknowledgement of reports and clear demonstration of an interest in working to implement the changes suggested. Punitive actions following on self-report will diminish the number of reports received.

Taking a cue from research in industrial incidents, ideally all reports should be kept in narrative form, in a computer database, in order to allow text word searches and accurate reconstruction of the events in future analyses.[118] There is, however, a danger in this approach. In theory, incident reports, as peer review documents, are not discoverable as legal evidence. This doctrine has been challenged repeatedly in court. Leaving a paper trail of error, while essential to improving practices, requires sound legal guidance.

Staff Survey. A regular staff survey allows quantitative evaluation of subjective perception. Staff perceptions, however, may change from day to day or even from hour to hour depending on the volume in the ED and the complexity of the last few patients seen. Nonetheless, a short survey provides an inexpensive and simple method to monitor patient safety. With a large percentage of ED staff surveyed, it may show changes in perception from month to month, tracking the success of any system implemented. Complications in interpretation of a subjective survey include that it may demonstrate a strong tendency toward both Hawthorne and anchoring effects, showing inflated values immediately following an intervention and then slowly falling values as perceptions return to baseline.

Ask Patients about Unexpected Events in Tele-

phone Follow-up. The addition of a few questions modifies regular quality assurance telephone follow-up to include patient safety. For example:
• Did anything happen after your visit that you did not expect? What?
• Did you experience unexpected discomfort following your visit?
• Did you have any problems with the medications prescribed or given to you in the ED?
• Did you visit another ED after your visit to our ED?
Asking these questions will serve as an alert to possible error and give an indication of what patients see as unexpected events.

Ask Primary Care Physicians about Unexpected Events in Patient Follow-up. This might be implemented in either of two ways. The simpler method is to place a notice at the top of patient dictations or charts sent to primary care physicians asking the doctors to "Please inform us if, in your follow-up, there are any unexpected or unusual events associated with this patient's emergency department visit. Please let us know of any drug reactions or complications of therapy delivered in the ED." This will require someone to field, record, and sort any responses.

A second method entails generating a monthly list of patient names for each primary care physician with patients seen in the ED that month. This list would be mailed, e-mailed, or faxed to the doctor with a request similar to that above. While requiring more concerted effort, this second method delivers the question to the primary care physician after any adverse events have had time to appear and so may yield a higher response rate.

Use a Broad and Inclusive Language of Medical Error. The vocabulary of medical error is still forming. Furthermore, the term "error" itself may be taken as judgmental or accusatory. Without being able to recommend a specific approach because different language may work in different situations and because it is not clear what approach to recommend, many terms should be considered and tried. Vocabulary for referring to error includes: mistakes, unintended injuries, unexpected events, patient safety, adverse events, barriers to care, and hindrances to care.

Teaching.

Include Medical Error and Patient Safety in EM Curricula. Medical error and patient safety are rarely discussed explicitly during medical school or residency. The orientation day of any new rotation is an ideal time to discuss the expectations of the rotation regarding error. Topics to include are:
• The necessity of asking questions if unsure about a procedure or an order.
• What to do if one makes a mistake while in the ED.
• What to do if one witnesses another person making a mistake in the ED.
• Basic teamwork concepts, including introducing oneself and verbally confirming orders.
• The role of incident reports and expectations regarding the completion of incident reports.
A discussion covering these topics should be added to orientation handbooks provided at the beginning of EM rotations.

In order to make thinking about error a more integral part of EM rotations, rather than simply something heard or read about during an orientation, time should be set aside for an M & M-type conference devoted to system-level analysis of medical error. Appendix B contains a preliminary copy of a guide for use in such a conference. In order to separate this discussion from student or resident concerns about grading, this conference should be conducted by someone without responsibility for student evaluation.

Educate Broadly about Error in Medicine and Efforts to Prevent Error. Public discussion has only recently focused on the topic of error in medicine. With the exception of occasional reports about the most shocking errors, such as wrong-sided surgery, the public receives little information about mistakes occurring in hospitals. This may change with publication of newspaper features like Tye's series on medical error in recent issues of *The Boston Globe*.[119]

Revealing the existence of error in one's own hospital is risky. Without public realization that uncovering error is an essential first step to preventing error, one may unwittingly portray one's own hospital as dangerous. On the other hand, to ignore the growing public exposure of error in hospitals risks finding that others, having admitted to the problem, can trumpet interventions. To the degree that quality is the basis for health care competition—a highly debatable proposition as cost appears to be far more important—those who have worked to reduce hospital error, and who have made their efforts known, will reap due rewards. The challenge is to raise awareness without frightening patients. An appropriate approach would emphasize "patient safety" and the efforts made to ensure appropriate and accurate care. In order to develop a culture of safety, it is essential that staff, too, are included in the educational effort.

Prevention. Avoiding harm has always been central to medicine, but it has not always shared equal attention with efficiency, education, and cost reduction.[120] Moreover, system design has played a much smaller role than individual responsibility in preventing error. Any intervention explicitly de-

signed to reduce error, and particularly any system-level intervention, plays a dual role: it directly aids care and it indirectly supports the development of a safety culture.

Emphasize Patient Safety, Not Just Adverse Drug Events. The majority of safety research in medicine focuses on adverse drug events. While reducing adverse drug events is one important piece of a larger effort to make EDs safer places, such reduction may be seen as the first, targeted strategy in a larger effort. A broader emphasis on patient safety leaves the way open for a second targeted strategy after successful efforts to reduce adverse drug events.

Implement Computer Order Entry. Bates et al. uncovered 1.4 medication errors per admission on inpatient units. Less than 1% led to adverse drug events, but a system of computer order entry would have prevented all of these.[22] While development of computer order entry is expensive, prevention of a single adverse drug event represents an estimated savings of $2,595, and possibly as much as $4,685, in hospital charges.[5]

Hennepin County Medical Center has reported the successful implementation of a computer order entry system (EmSTAT, WebMentors, Plainfield, IL), combined with a patient tracking system, in the ED.[121] Color-coded timers on a tracking board indicate when an order is in need of cosigning, outstanding, in process, or completed. An additional benefit of the system has been to provide data for process analysis. Unanticipated difficulties in implementation included reduced communication between physicians and nurses and difficulty canceling orders.

Computer order entry is a first step. Ultimately, all stages of drug and laboratory processing will be linked seamlessly. From drug order entry, for example, the computer will track, most likely through bar-coding, the dispensing of the drug and, ultimately, the administration of that drug to the appropriate patient. Any place where there is a bar-code reader, the order will be confirmed. Order confirmation at the bedside will automatically generate a precise record of medication delivery.

One downside to this innovation lies in the trust of the computerized system. Increased reliance on automation can lead to lax human operators. Errors that would be caught by hand may slip through when people assume that the computer cannot err.[122]

Develop a Computer-based Patient Tracking System. Emergency department staff cite tracking patients as a principal safety concern.[123] The method of writing patient names and locations on a dry-erase board cannot keep pace with a busy ED. Other methods of patient tracking should be considered.

Computer monitoring systems are one possible solution. A number are commercially available.[124] St. Joseph Health Services of Rhode Island has described a patient tracking system using bar code technology that integrates patient registration, location, and waiting times.[125] A designated nurse or secretary keeps logged patient information up-to-date. Patient ID cards with medical record numbers rendered as bar codes allow fast and accurate access to records. The use of a slot reader speeds laboratory and radiograph ordering. In the early 1990s, the reported equipment costs for the system totaled $8,000. Bar code technology has also been noted to decrease redundant labeling in laboratory ordering and to increase the accuracy of history taking in trauma resuscitations.[126,127]

Enact Smaller Changes Where Possible. An increased focus on patient safety and error reduction will produce a number of ideas that can be judged on their own merits and implemented as appropriate. With measures of error available, as discussed above, small changes may demonstrate a measurable effect in patient safety. Additional ideas include:

- Moving IV mixing to the central pharmacy, a more controlled environment.
- Marking all nonstandard IV mixes with bright red tape.
- Relabeling and repackaging as necessary to distinguish high-risk drugs or mixtures.
- Automatically delivering discharge summaries for all hospitalized patients to the admitting EPs.

Topics for Further Investigation.

Investigate Patient Opinions Regarding Medical Error. Very little knowledge exists about what patients know or imagine about medical error. This is not a topic typically included with patient satisfaction surveys. To the degree that patient opinion may drive or direct change in medicine, patient safety might become a quality indicator leading people to select a given health plan or hospital. Surveys, even if conducted in the ED while people are waiting, may help determine the patient point of view.

Determine the Best Practices in Patient Safety in EDs. Observations and interviews of ED staff may uncover a number of processes that might be considered best practices in error prevention and patient safety. These might include overreading and follow-up of electrocardiograms and radiographs, review of abnormal lab values, written orientation material for students and rotating resi-

dents, the use of nursing communication notes at shift change, and standardized order sets for specific high-risk pathology. In all likelihood, a number of EDs around the country have practices in place that could generate significant reductions in error if instituted, tested, combined, and promulgated.

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The Appendixes follow.

APPENDIX A

*Medical Error: Working Definitions**

Goals: 1. To provide a flexible, simple model in order to facilitate discussion, recording, understanding, and correction of medical error.
2. To define enough of a common language to promote communication while avoiding complex taxonomies.

Model	Systems failures	⇒	Intermediate factors	⇒	Error	⇒	Organizational defenses	⇒	Patient resilience	⇒	Potential adverse events	OR	Adverse events
Synonyms	Latent errors Process errors Design errors Root causes Ultimate causes The blunt end		Contributory factors		Mistakes Proximal causes The sharp end		Intercepted adverse events				Near misses		Incidents Injuries Complications Harm Accidents Iatrogenic injuries Sentinel events Celebrated cases
Definition	A system is a combination of interdependent parts or processes that share a common goal. Systems failures are the ultimate problems that create or perpetuate conditions that permit errors to occur.		Intermediate factors facilitate the occurrence of errors.		An error is the failure to perform a task by an individual or group. It is the immediate cause of an adverse event. It may occur by omission or commission. Cognitive scientists describe several types of errors, including slips and mistakes.		Organizational defenses are planned and unplanned behaviors or procedures that prevent, remove, or address error.		A patient's physiologic reserve mitigates injury in the event of an error. Age, acuity of illness, and underlying co-morbid illness each tend to decrease a patient's physiologic reserve.		A potential adverse event is an error that could have proceeded to an adverse event but did not.		An adverse event is an injury caused by medical treatment. Adverse events may occur without an antecedent error.
Examples	There is no standard method in place to record medication allergies.		A nurse, who worked a double shift, failed to verify a patient's allergies before administering a medication.		A physician ordered a medication to which the patient had a known allergy.		Nurses confirm drug allergies routinely before transcribing any physician's order.		A patient, after receiving a medication to which that patient is known to be allergic, has no reaction.		A patient receives a drug to which he is known to be allergic. There is no reaction.		A patient goes into anaphylactic shock after receiving a medication.
Questions	What set of conditions permitted an error to occur?		Why was it possible to err in this way?		Who erred and why?		Are there defenses in place? Did they prevent the error or compound it?				What might have happened?		What happened?

*Modified with permission from: Leape LL, Weingart S, Schenkel SM. Medical error: working definitions. Discussion materials for the Harvard Executive Session on Medical Error and Patient Safety, Harvard University, Cambridge, MA, June 1998.

APPENDIX B

Preventing Error and Promoting Patient Safety in the Emergency Department: A Guide for System Analysis

As someone who rotates through multiple hospitals but has spent the past month here, you have a unique perspective on patient safety and medical error in the Emergency Department. This perspective will inform your thoughts as we ask you, at the end of your month long rotation, to reflect on one error or one near error that took place during the month.

Dedicated, well-meaning people make very human mistakes that, without systems designed to catch them, can injure patients. The mistakes cover broad territory. Many have to do with drugs: the wrong drug delivered to the wrong patient or the right drug delivered to a patient with a known allergy to that drug. They range from the tragedy of a surgeon who operates on the wrong side of the body to the more typically benign case of the patient who leaves the ED without knowing what symptoms indicate a need to return. Another sort of error occurs when someone simply does not think of a possible diagnosis or does not request a potentially diagnostic test.

The purpose of the next hour is to reflect on a time in the last month when you felt patient safety was compromised. This is very similar to a regular M & M conference, except we will seek system level explanations for events rather than focusing on individual actions.

Incidentally, it would be highly unlikely for a month to go by without some sort of error occurring in an emergency department. Estimates suggest that for every 100 actions preformed on a patient—from physical examination to drug provision—there is an episode of error. It is even less likely for a month to go by without witnessing or noticing a near error—something that concerns you when your think what might have happened.

Here please pick one of those events for exploration.

We ask that you use no names: not the name of any patient and not the name of anyone with whom you have worked. You may write answers to these questions if you wish, but they may also be treated simply as guides for your thought.

Please take a moment to think over the last month in the ED.

From among your experiences, please select a single event of error or near error which you witnessed or took part in.

What are the details of the event?

What should have happened, had all gone well?

Which of the following were factors in the event? How so?

Equipment:

continued

Controllable environmental factors (seating, lighting, space):

Uncontrollable external factors (patient status, time of day):

Lack of information support (computer, reference material):

Lack of experience available:

Lack of available human support:

Other factors?

Any others?

What would you change such that this event would not occur again?

Please be sure to consider changes outside the Emergency Department as well:

Did you discuss this event with anybody? If not, why not?